Sustainability Fee Project Grant Report Guidelines
for grants awarded during FY2019
Due by 5pm August 1, 2019
Email pdf or word doc to cfs@georgiasouthern.edu

Please provide the following information in order to help the Center for Sustainability document the success of the Sustainability Fee Grant Program.

Date: 7/31/19
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Project title: One Step Towards Green and Sustainable Chemistry: Replacing Harsh and Corrosive Acids in Organic Chemistry Teaching Laboratories.
Amount granted: $10,023.00
Amount spent: $10,001.53 (The remaining $21.47 will be used for the grants FY 2020).

I. Project Outcomes/Value

The ultimate goal of this project was to replace toxic and corrosive acids such as hydrochloric (HCl) and sulfuric acids (H_2SO_4) from organic chemistry teaching laboratories with safer alternatives. In order to achieve this goal, six Organic Chemistry labs had been modified to utilize Dowex as a substitute for traditional inorganic acids. Dowex is commercially available, inexpensive polystyrene beads functionalized with sulfonic acid and possesses exceptional properties such as, its nontoxic, non-corrosive, thermal/mechanical stability and reusable. It has been used extensively in organic synthesis as catalyst for many years.

We specifically targeted to alter two Organic Chemistry I along with four Organic Chemistry II laboratory experiments. We found out that Dowex was able to successfully mimic traditional acids to obtain the expected products under similar experimental conditions. We successfully substituted three of the six experiments with Dowex and which dramatically reduces student contact to harsh and corrosive acids.

Project Timeline:

Below is the planned timeline we had for our proposal and we were able to complete all the activities mentioned in the timeline. We also presented our worked results in sustainability showcase.

Time	**Description of the work**
July 1 to September 2018	Hire the prep student and four undergraduate students to work on labs to be replaced. Six labs from Organic Chemistry I and Organic Chemistry II will be targeted to replace toxic and corrosive acids.
15 July to September 2018	Draft and edit the procedure of the lab with solid acid catalyst for the pilot study in fall 2018.
15th August to December 2018	Implementation of the greener lab as a pilot study in Organic Chemistry I and Organic Chemistry II.
15th July to December 2018	Data collection from the individual labs in the form of post labs.

15 November - December 2018	Voluntary satisfaction survey to be given to students.
January to March 2019	Data assessment for the greener labs and implementation of the successful labs in the upcoming lab manuals for print.
April to June 2019	Writing and dissemination of results and Outreach Activities

Project Outcomes – The major goal of this proposal was to target the experiments which use harsh, toxic and corrosive acids such as Hydrochloric acid (HCl) and/or Sulfuric acid (H_2SO_4) and replace them with safer, inexpensive and reusable solid acid catalysts. We were able to successfully accomplish this goal. We were only able to modify the experimental procedures for three out of the six proposed experiments. The unsuccessful experiment is due solely to hardware limitations and not being able to use a separatory funnel with beads. Also, filtration of the beads instead of liquid acids made as an additional step to be considered in the procedure, which required more explanation to the students. These challenges would be solved in future by showing clear demonstration and clear writing of the procedures.

Following labs were targeted for this proposal: Six experiments in the Organic Chemistry I and II courses were made greener with this funding. Our approach was to keep the overall procedure same as mentioned in the lab manual and only change the liquid acid with Dowex beads.

No.	Title and (*Results)*	Replacing acid	Target Course
1	Separation by Extraction – (*Separatory funnel used and difficult to remove beads.*)	Hydrochloric acid	Organic Chemistry I
2	Elimination of Alkyl Halides – Successful and adjustment needed (*Demos needs to be shown to students for extracting acids).*	Hydrochloric acid	Organic Chemistry I
3	Preparation of Azo Dyes – Successful and adjustment needed (*Demos needs to be shown and explained properly to students in writing and through videos).*	Hydrochloric acid	Organic Chemistry II
4	Iodination of Salicylamide – Successful!	Hydrochloric acid	Organic Chemistry II
5	The Compound W Project – Successful!	Sulfuric acid	Organic Chemistry II
6	Combinatorial Synthesis – Successful!	Sulfuric acid	Organic Chemistry II

Sustainability Improvements – There are twelve major principles of green chemistry. Our project addresses seven of these twelve principles: "Safer Chemicals and Products", "Safer Solvents and Reaction Conditions", "Use of Catalyst", "Analyze in Real-Time to Prevent Pollution", "Minimize Potential for Accidents", "***Less Hazardous Chemical Syntheses***", and "***Prevent waste***". Our project focused on the last two principles the most however. By adhering to these principles, we are able to prevent students from being exposed to harsh and corrosive acids while also preventing waste due to the reusable nature of Dowex.

Outreach – As we share this information and the results of our studies through student Sustainability fees, we are also eager to expose others, particularly, community colleges and four-year undergraduate institution like us. As such, our outreach will involve the wider scientific community. Through presentations on campus and in scientific meetings (regional as well as national), we will share our results with the STEM community. More specifically we will present our results at the STEM conference in Savannah. All participants (PIs, and undergraduate students) on this project will be involved in disseminating the work. Finally, **we have already successfully incorporated a lab in the 2019-2020 organic chemistry II lab manual.** In future, if we plan to publish the results of our efforts in peer-reviewed, scientific journals. Publications will allow us to reach an even broader audience by extending our outreach internationally. All the outreach material will contain *The Center for Sustainability Logo* and the statement '*Student Sustainability Fees at Work!*'

Budget report- We proposed the Budget as mentioned in the proposal and we were very close to maintaining it.

SALARIES, WAGES & FRINGE BENEFITS					**YEAR 1**
1.	**Salaries**				
A.	**Personal Investigator** *Dr. Shainaz Landge* *Dr. Abid Shaikh* **Other Personnel**	0			0
	One Prep Student (UG)	$12.0 hr/20hr wk/12wk			$ 2880.00
B.	Four Undergraduate (UG)	$10.0 hr/20hr wk/6wk			$ 4800.00
	Total Salaries				**$ 7680.00**
2.	**Operating Expenses** Consumables**				$ **2343.00**
Total Estimate (1+2+3)					**$10023.00**

****Consumables from Supplier -Sigma Aldrich**

Chloroform (Deuterated Solvents - **D**) – 500 gm * 2	$ 416.00
Acetonitrile-**D** - 25 gm	$ 149.00
Dichloromethane – **D –** 10 g *2	$ 308.00
Thin-walled NMR Sample tubes, (100 pieces) *2	$ 260.00
Chemicals (Dowex – H^+ - proton form – 5 Kg	$ 190.00
K-10 Montmorillonite - 3 Kg	$ 180.00
Thin Layer Chromatography (TLC) plates – 2 boxes	$ 436.00
Melting Point (MP) Capillaries	$ 208.00
Disposables – Gloves, syringes, pipettes etc	$ 196.00
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Total	**$2343.00**

II. Student and Community Impact:

Because these grant funds come directly from a $10 Student Sustainability Fee, it is important to document how they benefit students. Please provide information on the following:

#Undergraduate students employed by the grant, and length of employment (# hours/week for x weeks)

Four undergraduate students (($12.0 hr/20 hr/wk for 12 weeks)
One prep student was hired ($12.0 hr/20hr wk/ for12weeks)

students reached through classes or other means

Approximately 500 students will be reached yearly by performing the updated and modified Organic Chemistry laboratory experiments

Grant Leverage

Presentations given on grant work –

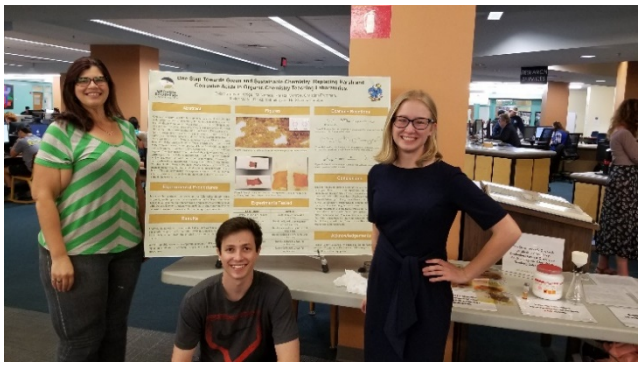
1) Poster entitled "One step toward Green and Sustainable Organic Chemistry" was presented at the Student Research Symposium on April 18, 2018.
2) Poster entitled "One step toward Green and Sustainable Organic Chemistry" was presented at the Sustainability Showcase.
3) "The Compound W" project in Organic Chemistry II lab manual, 2019-2020.

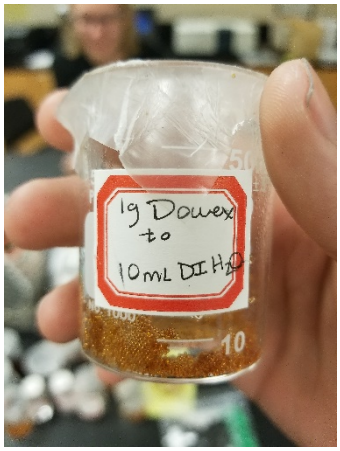
Project abstract

Organic Chemistry I and II Laboratory experiments are known for their wide scope and use of potentially hazardous, non-green chemicals. Specifically, they are known to use strong acids such as Hydrochloric acid and Sulfuric acid. Thankfully, there is a much safer and greener alternative to these strong acids known as Dowex beads. Dowex beads are small, golden-brown spheres which can act as Bronsted-Lowry acids by serving as a hydrogen donator while also being a green alternative. In these experiments, the Georgia Southern Organic Chemistry I Lab Manual and the Georgia Southern Organic Chemistry II Lab Manual were evaluated to see which labs could be replaced with the greener and safer alternative of Dowex beads. Two Organic Chemistry I labs and four Organic Chemistry II labs were tested side-by-side with the originally written procedure and the altered procedure, which replaced a strong acid with Dowex beads. Five of the six experiments worked just as well, or better, when the altered procedure was put into place. These findings will lead to the Georgia Southern Organic Chemistry I and II Lab Manuals being re-written to include the altered procedure with Dowex beads. This not only makes the experiments much safer for novice chemistry students to complete, but the reusable Dowex beads are also a much greener alternative.

Few pictures are shown below from sustainability showcase and from the organic chemistry lab.

Undergraduate research scholar presenting their work in sustainability showcase:





Azo dyes experiment showing the results from pure HCl and the one with Beads.